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Kansas, and only occur in the drift, and all are in small, inferior specimens.

16. Spinel Ruby was obtained by the writer, in the northern part of Riley county, in a stratum of fine clay shale. The crystals were small and full of fractures, rendering them unfit for jewelry. One was shown me, said to have been found near Milford, which was one-third of an inch across, and of clear, fine grain, which would make a lovely ornament.

17. Manganese, in the form of dendrites or ''forest rock,'' is common from all parts of the limestone deposits.

18. Quartz cannot be considered common in the State, but small crystals are found in every county covered by the carboniferous deposits. They sometimes occur as small geodes, and occasionally line the cavities of fossils. Chert is common in some of the lime strata, and in such cases follow the beds across the State. Agate, carnelian, chalcedony and jasper are found occasionally in the sand-bars of our streams, and belong to our drift deposits. Amethyst in fine crystals is found in the small area covered by the metamorphic rocks of Woodson county.

19. Silver, but in only a few ounces to the ton, has been discovered at the lead mines. It has never been obtained except in such connection.

20. Copper only occurs in very small quantities with iron pyrites.

21,22. For Lead and Zinc, see Geological article, in Agricultural Report.

COLOR-BLINDNESS, AND RAILWAY ACCIDENTS.

By John Fee, M. D.

The visual defect known as Daltonism, or color-blindness, has associated with it two sides—the one theoretical, the other practical. Viewed from a theoretical standpoint, it is connected with the wonderful phenomena of light and its properties, and with the sensitiveness of nerve matter in responding to this imponderable, and, as yet, scarcely understood agent, yet the means of our knowledge of external nature. As a practical topic, it is useful to those unfortunate individuals who, on account of their inability to perceive colors, are unfitted for many avocations, such as painters, artists, or for employment on board of ships, and on railways, in capacities in which they must display and read the language of signals. This practical phase of this subject presents an important question in forensic discussions, when chemists are giving expert testimony, on which depends the life of men charged with crime. No court ought at the present day receive the testimony of any chemist as an expert witness until it has been shown by sworn testimony that he has been tested for color-blindness. In this day of railways, when every one expects to travel, and does almost weekly or monthly use the railway car, the subject of color-blindness becomes of intense interest, and every person has a right to inquire whether this visual irregularity does endanger his safety and his life. I shall therefore treat this subject from a double view, viz., theoretical and practical. This subject may be said to be new in this country, and, in fact, it is only within the last decade that it has created any agitation in the scientific world. It is true, the existence of this deformity has been known for nearly a century, but prior to 1794 it had not received the investigation of a scientist. At this time, Dalton, the celebrated English chemist, discovered that he was color-blind, or rather red-blind, and that he did not see the solar spectrum as others saw it. This discovery of Dalton, and his investigations, secured for this irregularity the name of Daltonism, which is the favorite term of the French at the present day for color-blindness.

From Dalton's investigations, in 1794, until 1837, there is scarcely anything written on the subject. It seems to have been almost forgotten. In 1837, Dr. Seebeck, of Berlin, revived the subject of color-blindness, and re-investigated it, and invented tests for determining the frequency and extent of this defect. In 1840, Dr. Isaac Hays, editor of the American Journal of Medical Science, published a paper entitled "The Impossibility of Distinguishing Colors;" and in 1845, Dr. Pliny Earle published in the same journal the report of a singular history of the color-blindness of five generations in his own family. In 1855, George Wilson, Professor of Technology in the University of Edinburgh, published the first practical work on the subject. Wilson's researches were made in view of determining the influence of color-blindness in producing accidents on railways and at sea; and so thoroughly did he discuss this subject, that the Great Northern Railway compelled its employes to furnish satisfactory evidence of the perfection of their color sense. The wide-spread interest on this subject, and its agitation at the present time, are due mainly to the efforts of Prof. F. Holmgren, teacher of physiology in the University of Upsala, Sweden. He treats this subject from all standpoints—historical, theoretical and practical, and gives specific instructions for using colored worsteds for testing the color sense, which is every where known as the Holmgren method. The Professor has tested by his method great numbers of students, soldiers and railroad employes, and gives statistical results. In his native country, such has been the interest which his labors have awakened, that the Swedish Government has caused to be discharged from the railway service all persons found with impaired color sense. His book was quickly translated into the leading tongues of Europe, and into English by the Smithsonian Institution. The number of foreign scientists engaged in the study of this subject are too numerous to be mentioned, and I only insert here the names of Professors Donders, Mauthner, Hering and Helmholtz. This historical outline would be imperfect if I were not to add the name of Prof. B. Joy Jeffries, of Boston, who has written, in addition to numerous essays and reports on this subject, a work entitled "Color Blindness: Its Dangers and Detection." This is the most exhaustive treatise on this visual irregularity in our language; and, besides the experiments and original researches of the author, contains a compilation of most of our knowledge on the subject up to the time of its publication, in the early part of the present year (1880).

What then is color-blindness? Is it the absence of the perception of light? Is it a disease, congenital or acquired? Is it an objective or subjective defect?—an imperfection of the mind, or of its visual apparatus? Color-blindness is not blindness in the ordinary sense of the word. The visual apparatus is perfect as an optical instrument, and the person has a natural perception of light, and of the form and outline of objects. It is inability to perceive certain colors, usually red and green, and tints of the same; so that the individual cannot distinguish the difference between the color of the leaves of a tree and its fruit. "The color-blind, however, see white and black, and their intermediate and compound, gray, provided they are free from alloy with other colors, precisely as others do."

Again, there are two colors properly so called which they see, namely, yellow and blue, which also if unalloyed they see in the normal manner. But these are the only colors of which they have any sensation, and hence their defect has been called by Sir John Herschel dichromic vision. ("Color-Blindness, Its Dangers and Detection," by B. Joy Jeffries, page 42.)

Here we digress for a moment to state that the evolutionists claim to find in the existence of this defect evidence of their favorite doctrine. According to Geiger and others, what would now be color-blindness was the normal condition of our remote ancestors; the sensibility to colors enjoyed by the present generation is the hereditary result of education prolonged through many generations; in other words, the color sense has been developed by a process of evolution. This theory, developed some years ago by Geiger, who has recently died, has been recently developed at considerable length by Hugo Magnus, Professor of Ophthalmology in the University of Breslau. Magnus divides the colors of the spectrum into three classes: those richest in light, red, orange and yellow; that which has a medium degree of luminosity, green; and those which are feeblest in light, violet, indigo and blue; and argues ingeniously and learnedly to show that the advancing ages acquired each in turn. He maintains that primitive man possessed only the sense of light; that red was the first and violet the last color to be recognized, and that it is not impossible that our descendants may acquire the appreciation of colors that escape the present generation. Geiger stated that the Rig Veda contained no mention of green, blue or violet, and similar statements have been made of the Koran and of the Bible. Magnus says that Xenophon saw only three colors—red, purple and greenish-yellow, in the rainbow, and that the Homeric poems belong to the same color period, as they confound green with yellow. The mention of the Homeric age brings Mr. Gladstone to his feet, who fully adopts the views of Magnus, and shows that Homer perceived red and yellow, but confused green with yellow, and blue with black. ("American Journal of the Medical Sciences," October, 1878, page 474.) We have not time to investigate the Darwinian theory, and pass on.

There are two leading theories in regard to color-blindness, which we shall now examine. The oldest and most popular doctrine is known as the Young-Helmholtz theory, so named after Young, the English physicist, who first taught it, and called Helmholtz, because after it had been forgotten it was rescued from forgetfulness by Prof. Helmholtz, of Berlin. This theory recognizes three base colors—red, green and violet, and consequently three kinds of corresponding elements in the organ of the optic nerve, elements respectively perceiving red, green and violet. "Objective homogeneous light excites these three fibers in varying degree, according to the wave-lengths. The red perceptive fibers will be most strongly stimulated by light of the greatest wave-length, the green perceptive by light of medium wave-length, and the violet perceptive by light of the shortest wave-length.'' Prof. Helmholtz is not certain, however, whether there are three kinds of nerve filaments proceeding from the visual cones of the retina, or whether there are three kinds of nerve action in each nerve filament. He says:

''Perhaps there will be much objection to this hypothesis from the number of the necessary nerve fibers or nerve terminations being tripled, in comparison with the common theory in which every individual nerve carries all possible color stimulants. I do not think, however, in this respect, Young's theory is in opposition to any anatomical facts, since we know nothing of the number of transmitting fibers; and then, besides, there are a number of microscopic elements present, the special function of which we do not as yet know. Moreover, this is not the most essential part in Young's hypothesis. That seems to me to be the presenting of color sensations as composed of three wholly independent actions in the nerve substance. It is not absolutely necessary to suppose separate nerve fibers for these separate nerve sensations. The same value of Young's hypothesis in this explanation is shown, if we suppose that in each individual fiber three different and independent actions may take place. Since, however, the form of the hypothesis, as originally proposed by Young, is capable of a more definite presentation and expression than such a modification of it would allow, we will in view of its description retain the original and plainer form. Moreover, the physical phenomena of nerve stimulation, namely, the electro-motor, are not marked in the sensitive nerves and motor nerves by such a variation in action as would necessarily be the case if each nerve fiber transmitted all color sensations. By Young's hypothesis we may apply to the optic nerve the conception of the mechanism of stimulation and conduction which we have derived from the study of the phenomena of the motor nerves. This we could not do, if we must admit that each optic nerve fiber is to have three qualitatively different conditions of stimulation, without mutual interference. Young's hypothesis is only a more special carrying-out of the doctrine of the specific energies of the senses. As the sense of touch and the sense of sight in the eye have evidently separate nerve fibers, so is the same claimed for the sensation of the several base colors. The choice of the base colors is somewhat arbitrary. Any three colors could have been chosen whose combination produces white light. So far as I see, at present, there is no other way of determining the base colors than by the examination of the color-blind.'' (Jeffries Op. Cit., page 28.)

In support of the Young-Helmholtz theory, its advocates offer these additional physiological facts: ''Around the point of best vision, in the center of the retina, is a zone, where we perceive all of the three so-called base colors—red, green and violet. Outside of this is another zone, in which we have a perception of only two colors, namely, green and violet; and again, beyond this, and more externally on the retina, only blue or violet is perceived.'' The advocates of the Young-Helmholtz hypothesis hold, therefore, to three kinds of color-blindness—red blindness, green blindness and violet blindness. For the present we dismiss the Young-Helmholtz theory, and take up that of Prof. Hering, of Prague. I copy from the American Journal of Medical Sciences Prof. Hering's theory, as stated by Prof. Mauthner:

"According to this theory, vision is produced by the action of light on three separate and distinct chemical substances, which he calls the black-white, the red-green and the blue-yellow. Sight acts on these substances by assimilation and dissimilation. Dissimilation of the black-white substance produces the sensation of white, its assimilation black. As regards the red-green and blue-yellow substances, Hering is undecided as to the D and A colors. But if we take the red and blue as the D colors, the D of the red-green substance would produce red, its A green, and the D of the blue-yellow substance would call forth blue, and its regeneration yellow. All the rays of the solar spectrum act in a dissimilating manner on the black-white substance: that is, they produce the sensation of white, but in different degrees, the yellow acting most powerfully, the others decreasing in power toward the two ends of the spectrum. On the blue-yellow and red-green substances there are certain rays which act in a dissimilating manner, some in an assimilating manner, and some not at all. If the A and D of the black-white substance are of equal intensity, the result is gray. If the A and D of the red-green and blue-yellow substances are equal, the result is negative as to color, and there only remains the dissimilating action of those colors on the black-white substance, that is white. (Amer. Jour. Med. Sci., Oct. 1880, page 532.) According to Hering, therefore, the so-called complementary colors are not complementary, but on the contrary, antagonistic. By their mixture they do not produce white, but being neutralized they allow the white sensation, which they all produce, in a greater or less degree, to come prominently forward. The phenomena of color-blindness, as based on this theory, are as follows: In the achromatrope all the rays of whatever refragibility, acting in a dissimilating manner, white or its shade, gray, is produced. In the dichromatrope, besides the black-white there is only one other substance that can be acted on by the different color rays. If this is the blue-yellow (constituting red-green blindness), the red-yellow and green light act in a dissimilating manner, and the blue in an assimilating manner. The most strongly dissimilating color is yellow; the others are varying—sometimes the red is stronger than the green, and vice versa. To some of the light-waves at the red end of the spectrum, the colored as well as the black-white substance is insensible. In the same way, in case of blue-yellow blindness, where there is only the red-green substance, in addition to the black-white substance, the red-yellow and blue lights act dissimilatingly, and the green assimilatingly. The D color is red, the A color green, and there are certain color rays at the blue end of the spectrum which do not act on either one of the substances. In this case we should have a shortening of the spectrum at the blue end; as in the former case, there would be a shortening of the red end. As an A and D of equal intensity of any one-color substance would result in a total abolition of both colors, so where we have such an action in the case of a dichromatrope, there would be no color perception at all, but only the sensation produced by the action of light on the black-white substance, that is, gray. It is on this account that certain shades of color appear as gray to the dicromatrope. Purple and bluish green are the colors which most dichromatropes confound with gray; but as the dissimilative power of any is not the same in all dichromatropes, we should not expect to find, according to this theory, the same shades of those colors to be invariably confounded with gray. To one, a certain shade would appear gray, which to another would be blue, and to a third yellow, owing, of course, to the preponderating color after the action of the opposing colors.

"It will be seen, from this point of view, there can be but two forms of color-blindness, according as the one or the other of the color substances is lacking, but as such color substance, by its A or D action, represents two colors, a color-blind individual must be either a dichromatrope or an achromatrope. Hering, therefore, recognizes only red-green blindness, or blue-yellow vision, and blue-yellow blindness and red-green vision, and achromatopsia, or simply the perception of light and darkness." (See Amer. Jour. Med. Sciences, Oct. 1880, page 533.)

To my mind these theories seem ingenious but unsatisfactory. The latter is perhaps more serviceable as a hypothesis. The idea of the existence of separate nerve filaments for the conduction of the different waves of the base colors has no evidence in microscopic anatomy. Once accepted, we shall have a convenient hypothesis for explaining all the qualificative functions of the other cranial nerves. We can hold that the filaments of the olfactory nerves correspond in unlike character, and qualitatively to the different odors that excite them. The same reasoning would be applied to the auditory nerves, and to the gustatory branch of the pneumogastric. As to the different color zones of the retina, we can explain, by saying they are the result of chromatic aberration. The mind perceives the colors where they really are, as the shorter rays first come to a focal point, and then disperse in circular waves over the retina. Further, we know that perception is a mental operation, and is subjective, and not the act of nerve filaments of conducting nerve matter, but is the functional act of the brain cells in which they terminate. Whatever properties there are in objects and light, for the formation of color, must be differentiated by the mind, or that part of it with which the color sense is associated. Late researches show conclusively that the different functions of the mind are associated with different areas of nerve matter, of the cortical substance of the brain, and that the congenital absence of one of these centers, or its destruction by disease, will abolish some functional action of the mind. These areas have been mapped out with considerable certainty as centers of motion and sensation to the various groups of the muscular system; and other important functional areas have also been discovered, such as the speech center. Again, it has long been known that color, light and form have different areas of perception, and that both the perception of light and form can exist independently of the perception of color. The most reasonable hypothesis, or to my mind conclusive explanation of color-blindness, is, that it is a congenital defect, and results from the non-development of the area for the perception of color.

The influence of heredity on mental function has been greatly overlooked. I hold that mental power is both quantitatively and qualitatively more influenced by heredity than by outside influences or education. In a word, I hold that Lock's teachings as to the source of mental power are contradicted by the heredity of genius, the heredity of crime, and all the phenomena of insanity. Color-blindness is, then, a congenital defect, a defect of involution, and consequently cannot be remedied by education. Several French writers have claimed that by systematic efforts the color sense could be developed in the color-blind, but it is evident from their writings that they have confounded a weak or impaired sense or knowledge of color with color-blindness. Persons who are slow and uncertain in designating color can be educated in chromatics, but the color-blind never. And here permit me to make an observation, in digressing from my subject; it is this: the hardest blow dealt to evolutionists theoretically is, that a qualitative mental function being absent, it cannot be developed by efforts at education; but if a mental characteristic exist, however weak and small, it may always be educated. Hence, it would seem that evolution must always be qualitatively what has first been involuted.

Let us now consider briefly the relation of color-blindness to railway accidents. It is well known that colored signals are absolutely necessary to the management of railways, particularly at night. It has been proposed to substitute form for light, for signals; but the appreciation of light is so much quicker and easier than that of form, that the change has been found impracticable. The ability, therefore, to determine the language of colored signal lights is absolutely necessary to train-men; and consequently, the safety of trains is endangered just in proportion to the number of employes who are defective in the color sense. The extent of this visual deformity can be tolerably accurately determined by statistics. "Dr. Fortenoy found thirty-one color-blind out of 1,084 railroad employes of Denmark, or 2.87 per cent. Prof. Donders, of Utrecht, Holland, found, among 2,300 railroad employes, 152 color-blind. Dr. Stetling, of Cassel, Germany, found, out of 400 railroad employes, six per cent color-blind. Dr. Krohm, in Finland, found, among 1,200 railroad employes, sixty, or five per cent, color-blind. Dr. Holmgren found, among the employes on the railroads in Sweden, 4.8 per cent color-blind." (Jeffries' Op. Cit., p. 143.) From the number of railroad employes tested for the color sense in Europe, and persons examined in this country in the schools, we can assert that there are five per cent of the male population absolutely color-blind, and about five per cent in addition who have an imperfect perception of color. It is also known that the majority of persons who have this defect are unaware of it, or do not know the extent of their deformity. It is apparent, therefore, that this imperfection must be a great factor in the production of collisions and other accidents on rialways. On most railways, red lights signify "danger," white or yellow light, "track clear," and green light, at way-stations, "stop for orders." No person will deny that a certain number of accidents will happen from carelessness and inattention, especially where great numbers of persons are engaged; and if this is so, how can accidents fail to occur among a vast number of persons, of whom five per cent are absolutely incapacitated for discharging the duties assigned to them? That color-blindness is the source of accidents and calamities on railroads, in which property and life are sacrificed, is as apparent as any fact in pure mathematics.

How shall railway accidents and dangers be prevented? Simply by seeing that no men who have this visual defect be employed as train-men; that is, in the capacity of engineer, stoker, brakeman, conductor, or switch-man. This result can be secured by examinations, as first suggested by Wilson in 1855. It is accomplished, according to Prof. Holmgren's method, by having the person to be tested match colored worsteds. For the purpose of making the examinations, colored worsteds are procured, and placed in a pile on a table or large plane surface. The examinations are made in daylight. "The selection of worsteds includes red orange, yellow, yellow green, pure green, blue; violet, purple pink, brown, gray; several shades of each color, and at least five gradations of each tint, from the deepest to the lightest. Green and gray, several kinds each of pink, blue and violet, and the pale-gray shades of brown, yellow, red and pink, must especially be well represented.* The colors are divided into sample colors, consisting of green, purple and red, and confusion colors, made of every shade and tint of the solar spectrum. The first test consists in matching the sample green color. He who places beside the sample color one of the colors of confusion—that is to say, finds that it resembles the test color—is color-blind. He who, without being quite guilty of this confusion, evinces a manifest disposition to do so, has a feeble chromatic sense. Second test: A purple skein is presented. The color chosen must be between the deepest and lightest shades of the scale. Diagnosis: He who in the second test selects with purple only blue and violet, or one of them, is completely red-blind. He who in the second test selects with purple only green and gray, or one of them, is completely green-blind. Test third: The red skein is presented to the subject. It is necessary to have a vivid red color, like the red flag used as signals on railways. This test, which is applied only to those completely color-blind, should be continued until the person examined has placed beside the specimen all the skeins belonging to this shade, or the greater part, or else, separately, one or several colors of confusion. The red-blind then chooses, besides the red, green and brown shades, which to the normal sense seem darker than red. On the other hand, the green-blind selects opposite shades which appear lighter than red. Violet-blindness will be recognized by a genuine confusion of purple, red and orange, in the second test." (See "Color-Blindness," by F. Holmgren, page 185—Report of Smithsonian Insitution, 1878.)

In conclusion, Mr. President, permit me to say that the principal object I have had in view in preparing this paper has been to interest this Academy in the subject of color-blindness, and through it the Legislature and his Excellency the Governor of the great commonwealth of Kansas. I believe that when this subject is properly presented to the legislators of your State, that some protective legislation can be secured against railroad collisions, so as to render transit on railways less perilous to life. I need not point out to you the numerous so-called accidents and catastrophes that have been chronicled in the United States during the present year. They are not altogether the result of carelessness or criminal negligence, as too often supposed, but result from the visual defect which I have just pointed out. As men of science, I appeal to you who can take a broader view of the subject than the employes of the railways, or even the men whose capital and wealth are invested in these corporations. I know that any legislation on this subject will be characterized as visionary, as yielding to the imagination of impractical men. But our mission is missionary. It is our duty to create, to mould public opinion, and not to vacillate before the scoffs and jeers of those who hold pure progressive science in ridicule. In many places in Europe stringent legislation exists in regard to the employing of the color-blind by railway corporations. In other countries, the railway corporations have provided the necessary safeguards without the compulsion of legislation. In our country, the National Government has not been slow to appreciate the importance of this subject. By order of the Surgeon General of the navy, all persons connected with the navy have been tested for the color sense, and a record of all defects of this kind are filed with the Department. I presume that Congress will be asked to order the discharge from the navy of every person found color-blind. Hon. John Sherman has issued orders to all inspectors of licenses to have all pilots of steam vessels tested for color-blindness, and to withhold licenses from all persons affected with this defect. In the army all recruits are examined, and all found color-blind are marked unfit for the signal corps.

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*The word purple here does not designate the color that has that name in this country. It it known to us as Victoria rose, and is said to be carmine diluted with white.

The agitation of this subject has already commenced in several of our State Legislatures, thanks to the untiring efforts of Dr. Joy Jeffries, of Boston. Massachusetts is deliberating before and discussing the policy of legislation. Connecticut has already passed a stringent and ample law controlling railway corporations in regard to employing the color-blind. Its character may be inferred from the second section of the law, which reads as follows: "Any railroad company or trustee operating any railroad in this State, employing, after the first day of October next, in any of the capacities specified in the second section of this act, any person who does not possess a certificate of freedom from color-blindness, and possession of normal visual power, duly issued in accordance with the provisions of this act, or knowingly employing in any such capacities any person whose certificate has been revoked by the examiners, shall, for each and every offense, be punished by a fine of not less than two hundred dollars nor more than one thousand dollars." Approved March 25, 1880.

Mr. President, I trust the time is not far distant when the agitation of this law will invade this temple of justice and wisdom. From its sacred precincts numberless edicts have gone forth in defense of humanity, which have given the commonwealth of Kansas the proudest position in the sisterhood of the Union. I am happy in believing that there is no subject that concerns the safety of human life, too lowly or insignificant to be introduced here; nor is there any prejudice or vice, or evil or crime, so insolent or contumelious as to intimidate the Goddess of Liberty and Humanity, who has her home within this temple.

THE RAINFALL IN ITS RELATIONS TO KANSAS FARMING.

By H. R. Hilton.

Political economists tell us that the foundation of the wealth and prosperity of a nation lies in the productions of its soil.

Science tells us that the successful production of crops is dependent